

Hydrologic Modeling Inventory

Model Response Form

Name of Model:**GR4J**

(stands for : modèle du Génie Rural à 4 paramètres Journalier (i.e. Rural Engineering Daily 4-parameter model))

Model Type:

GR4J is a daily lumped continuous rainfall-runoff model. It is of the soil moisture accounting storage type.

Model Objective(s):

The GR4J model was designed for streamflow simulation. It can be applied for a wide range of hydrological modeling applications (series extension, management, forecasting, design, trend detection...).

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Web: <http://www.cemagref.fr/webgr/>; <http://www.cemagref.fr/>**Technical Contact and Address:**Charles Perrin (charles.perrin@cemagref.fr)Vazken Andréassian (vazken.andreassian@cemagref.fr)Claude Michel (claude.michel@cemagref.fr)**Model Structure or Mathematical Basis:**

The GR4J model (see Perrin et al., 2003, for a full model description of the latest model version) is a daily conceptual rainfall-runoff model developed for applications at the basin scale (lumped mode).

The model has been continuously developed since the beginning of the 1980s. The first model basis was set by Michel (1983) and then successive improvements were proposed by Edijatno and Michel (1989) and Edijatno (1991), Nascimento (1995), Edijatno et al. (1999), Perrin (2000) and Perrin et al. (2003).

The production module of the model involves:

- an interception function between raw rainfall and potential evapotranspiration;
- a soil moisture accounting store to determine actual evapotranspiration and effective rainfall;
- a water exchange term that represents natural imports or exports of water (e.g. with deep aquifers)

The water transfer module involves:

- a separation of effective rainfall into two water component with a fixed volumetric proportion (0.1 / 0.9);
- two unit hydrographs to simulate time lag between rainfall and flow;
- a non linear routing store to route the main water component.

Model Parameters:

The model has only four parameters:

- the capacity of the production store, X1;
- the water exchange coefficient, X2;
- the capacity of the routing store, X3;
- the time base of the unit hydrograph, X4.

The parameters have no direct physical interpretation and must be calibrated using observed flows.

Spatial Scale Employed in the Model:

The model is to be run in a lumped mode.

Temporal Scale Employed in the Model:

The model is to be run at a daily time step.

Input Data Requirements:

The model requires as only input:

- daily time-series of observed catchment areal rainfall;
- daily time-series of potential evapotranspiration estimates (a mean interannual regime curve may be sufficient; see Oudin, 2004; Oudin et al. 2005).

Daily observed streamflow time-series will be necessary to calibrate model parameters.

Computer Requirements:

Given its very simple structure, GR4J can even be run in a spreadsheet, there is no specific requirement.

Model Output:

The model simulates daily streamflow time-series.

Parameter Estimation / Model Calibration:

Simple local search optimization algorithms are sufficient to locate a satisfactory model parameter optimum. A "step-by-step" method developed at Cemagref provides satisfactory results. Comparisons with more complex global search algorithms (see e.g. Nascimento, 1995; Mathevet, 2005) did not show significant differences for this model.

Model Testing and Verification:

Model code was extensively tested and verified all along the successive steps of model development.

Model Sensitivity:

Model sensitivity to input data (rainfall and evapotranspiration data) was studied by Andréassian et al. (2001,2004) and Oudin (2004) and Oudin et al. (2005).

Model sensitivity to output calibration data was studied by Rojas-Serna (2005).

Model Reliability:

The assessment of model reliability was studied by Yang and Parent (1996) and Kuczera and Parent (1998).

Model Application / Case Studies:

All along its development, the model was extensively tested on several hundreds of catchments:

- in France (Edijatno, 1991; Nascimento, 1995; Perrin, 2000; Oudin, 2004);
- in the United States (Perrin, 2000; Oudin, 2004);
- in the Australia (Perrin, 2000; Oudin, 2004);
- in Mexico (Rojas-Serna, 2005);
- in the Ivory Coast (Perrin, 2000);
- in Brazil (Perrin, 2000);

The largest dataset used to test the model amounted to 1111 basins (Rojas-Serna, 2005).

The model was also applied for a large number of research and operational applications, e.g. in flood forecasting (Yang and Michel, 1999; Tangara, 2005).

Documentation:

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